National Air and Radiation Environmental Laboratory

Environmental Radiation Ambient Monitoring System (ERAMS) Quality Assurance Manual

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National Air and Radiation Environmental Laboratory
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ERAMS Quality Assurance Manual

REVISION HISTORY

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1.0 INTRODUCTION

1.1 Purpose

This document describes the management structure, principles, and policies of the Environmental Radiation Ambient Monitoring System (ERAMS) at the Environmental Protection Agency's (EPA) National Air and Radiation Environmental Laboratory (NAREL). The purpose of the Quality Assurance Manual (QAM) as presented in this document is to ensure that work performed for ERAMS is done efficiently and in a manner that guarantees results of demonstrably high quality appropriate for their intended purposes. This QAM describes the quality assurance (QA) policies and procedures which encourage, allow, and document responsible management of ERAMS at NAREL. ERAMS operates as a program at NAREL and this QAM is issued under the umbrella of the NAREL Quality Management Plan (QMP).

1.2 Background

The U. S. Environmental Protection Agency (EPA) requires accurate, reproducible, and defensible data to evaluate environmental conditions, to assess potential health hazards, and to ensure compliance with its orders and regulations. To achieve these ends, data must be of known and desired quality. Policies initiated by the Agency Administrator in 1979 require that all EPA laboratories, program offices, and regional offices participate in a centrally managed quality assurance (QA) program. The Agency's policy and program requirements to implement the mandatory QA program are set forth in EPA Order 5360.1, Change 1, dated July 1998. The order requires each EPA organization collecting or using environmental data to develop and implement a management system of quality assurance (QA) and quality control (QC) to assure that the collected data are of the type and quality needed for EPA decisions.

Each EPA program office and laboratory must develop and maintain a centrally managed quality assurance program which must include those monitoring and measurement efforts mandated or supported by EPA through regulations, grants, contracts, or other formal agreements. The Agency QA policy states that each EPA laboratory, regional office, and program office must prepare a Quality Management Plan (QMP) covering all intramural and extramural monitoring and measurement activities that generate and process data for Agency use. The QMP provides guidance, and defines the QA management philosophy, structure, policies, responsibilities, and procedures for NAREL.

At NAREL, under the umbrella of the QMP, there are levels of documentation related to quality assurance and quality control. The first level is the Quality Assurance Manual, which presents technical criteria for analytical and administrative tasks to ensure that all data produced will be of known and desired quality, that all measurements performed at NAREL are valid and scientifically defensible. It includes specific technical processes, quality control requirements, information on analytical procedures, criteria for technical measurement processes, and corrective action criteria for the specific area of the laboratory. There may be one or more QAMs at NAREL, each applying specific technical information and criteria to a particular program or area of the laboratory. A QAM provides a detailed program for evaluating QC procedures and assessing results produced in the branch or program.

Quality Assurance Project Plans (QAPP) describe in detail the necessary QA, QC, and other technical activities that must be implemented to ensure that the work performed on a specific project will satisfy the required performance criteria. Each project conducted by or for NAREL requires a QAPP. The QAPP is required to ensure that the analytical, sampling, and other programs meet the required data quality

objectives (DQO) that have been established for the project.

The next level of documentation is the standard operating procedure (SOP), which details each step in a particular process or procedure, along with specific guidance for quality control requirements and criteria for corrective actions. The SOP must be sufficiently detailed that a qualified person can correctly perform the operation, analysis, or action with minimal additional help or explanation. SOPs are appropriate for routine and repetitive activities and should represent a standard procedure or protocol which has been tested and shown to lead to reproducible results under the conditions specified.

In addition to these levels of documentation, there may be written policies which must be clearly written and as specific as possible. All policies at NAREL must be written, and clearly presented to all staff who must operate under the policy.

1.3 History

The Montgomery laboratory was founded in 1941 through a grant from the Rockefeller Foundation to study influenza. In 1946 it was expanded by the U.S. Public Health Service to become a research station for studying viruses and other agents, including those causing polio, German measles, and leprosy. Radiation work began in 1959 when the Public Health Service's Division of Radiological Health (DRH) took over the site, and the laboratory became known as the Southeastern Radiological Health Laboratory (SERHL). The primary mission of this organization was based on the Federal Radiation Council's commitment to monitoring environmental radioactivity for the protection of the general public. In the mid-sixties the DRH concentrated on studies of releases from nuclear reactors, radiation safety training, and monitoring for fallout from nuclear weapons testing. In 1965, the SERHL operated under auspices of the National Center for Radiological Health (NCRH) and in 1968, under the Bureau of Radiological Health (BRH).

With the creation of the Environmental Protection Agency (EPA) in 1970, the laboratory began operating as a part of the Agency's Radiation Office and was renamed the Eastern Environmental Radiation Laboratory (EERL). After three years, the laboratory's name was changed to the Eastern Environmental Radiation Facility (EERF). Although the primary mission of the facility was to monitor levels of radioactivity in the environment, over time the laboratory assumed other tasks and responsibilities including emergency response, field monitoring at sites such as Three Mile Island, field studies related to radiation, and Superfund support work. In 1973, the EERF became part of the Office of Radiation Programs (ORP) and in 1989 was renamed the National Air and Radiation Environmental Laboratory (NAREL). In 1993, ORP was reorganized and renamed the Office of Radiation and Indoor Air (ORIA).

Prior to the formation of EPA in 1970, the PHS and BRH had primary responsibility for environmental radiation monitoring in the United States. Reorganization Plan No. 3 of 1970 created the EPA and transferred the responsibility for collating, analyzing, and interpreting data on environmental radiation levels to the newly formed agency. In 1973, EPA combined several existing environmental radiation monitoring networks into one and formed the Environmental Radiation Ambient Monitoring System (ERAMS). ERAMS stations are located across all fifty states and regularly sample the nation's air, precipitation, drinking water and milk. ERAMS operates continuously throughout the year and has emergency monitoring capability in the event of a nuclear emergency.

Most stations are located in major population centers and the system provides broad geographical coverage of the nation. All station operators are volunteers provided mainly by state government agencies or, in some cases, local government bodies. ORIA has oversight management responsibility for ERAMS but delegates the routine management and operation of the system to NAREL. NAREL maintains the flow of supplies and information necessary to keep all stations coordinated and operational, analyzes all samples collected by the national network and reports all data in *Environmental Radiation Data (ERD)* reports. ERAMS is the nation's only comprehensive environmental radiation monitoring program and has provided the EPA with an extensive database of environmental radiation data throughout its years of operation.

2.0 QUALITY ASSURANCE POLICY

2.1 Policy

The National Air and Radiation Environmental Laboratory (NAREL) is committed to the production of quality analytical data for ERAMS samples. The laboratory staff and management recognize that the achievement of quality data depends upon an effective and consistent quality assurance program. The implementation of the quality assurance program is achieved through a team effort of the entire laboratory group, from management to laboratory analysts. The general considerations and objectives of the overall program are as follows:

- Sample integrity must be preserved by following documented sample handling procedures relating to the preservation, custody, storage, labeling and record keeping associated with samples received by the laboratory.
- Proper approved standard analytical methods must be followed. Routine analytical methods and procedures used for sample analyses must be readily available and understood by all analysts using the procedures. Results generated from a method must be evaluated to identify method weaknesses and detect needs for further analyst training.
- The analytical instrumentation must be in proper working order. Instrument performance, calibration, and proper maintenance must be documented.
- The accuracy and precision of analytical methods must be recorded and maintained on a continuing basis. Accuracy and precision data are monitored by using control charts to assess continuing performance and to detect trends.
- Raw data must be properly reduced and accurately transcribed to the proper reporting format. Various levels of data review from acquisition to the final report are incorporated to reduce possibilities of error.
- NAREL is in compliance with and intends to remain in compliance with Federal, State, and local regulations regarding disposal of hazardous wastes.
- All of the above considerations must be documented to validate the quality of the data.

2.2 Measurement Quality Objectives

The basic measurement requirement is to produce scientifically valid, defensible data of known and specified precision and accuracy. The quality of data is defined in Data Quality Objectives (DQO's) by the Project Coordinator having management oversight and primary responsibility for the project. The laboratory's Measurement Quality Objectives (MQO) are the most important part of the quality assurance project plan (QAPP), because they relate the exact requirements of the project for the measurement data. MQO's may be described in terms of the following measures:

- Precision: Precision describes the ability to obtain the same result on repeated measurements. It is expressed in terms of standard deviations, percentage points, or

  the units of the measurement. The precision objective will vary over different concentration or quantity ranges. The QAPP should specify the amount by which replicate measurements may differ and still be acceptable.

- Accuracy: Accuracy describes the ability to obtain the accepted true result. Accuracy is generally expressed as a percentage or in the units of the measurement, and varies as a function of concentration or quantity. The QAPP should provide the permissible disagreement between a measurement of a standard and the "true" value of that standard.

- Representativeness: Representativeness refers to the extent to which the material on which measurements are made represents the material on which judgments are to be made. For example, resources are usually not adequate to sample and measure more than a small aliquot of the total entity being studied (e.g., surface water in a lake or river, soil at a contaminated site, vegetation). Thus, it is important to select samples carefully, for their usefulness may depend in large part on how representative the sample is of the whole entity to be measured. A grid system of sampling is often used in these cases. Nevertheless, the sample/measurement must be distributed in space and time. Obvious irregularities (e.g., stones or sticks in a soil sample) should be rejected, and bulk samples should be thoroughly mixed. The QAPP should provide the area or volume to be included, the total time over which the measurements (samples) are to be made, specifications for random sampling, if appropriate, and the frequency of sampling and measurement.

- Completeness: Completeness describes the number or fraction of the measurements or samples collected which yield useable data. The QAPP must specify the degree of completeness required

- Comparability: Comparability refers to the kinds of measurements and the units in which the results are expressed. Each QAPP must specify the units in which results are to be reported. Results should be reported in a standard form and expressed clearly. For example, "pCi/kg" and mg/kg are ambiguous, but "pCi/kg dry weight" and mg/kg wet weight are unambiguous. To achieve optimum comparability, the QAPP should specify acceptable methods for collecting and preserving samples, sample holding times, and sample analyses, either by identifying approved procedures or by specifying in detail the performance requirements, acceptance procedures, and documentation needed for alternative methods.

3.0 ORGANIZATION AND RESPONSIBILITIES

3.1 Organization

The QA organization at NAREL includes the Laboratory Director, the Quality Assurance Coordinator (QAC), Program Managers, Project Coordinators, Branch Chiefs, and Technical Staff. The ORIA Quality Assurance Manager (OQAM) oversees the NAREL QA Program. Figure 3.1 shows the organization of NAREL as of October 2000.

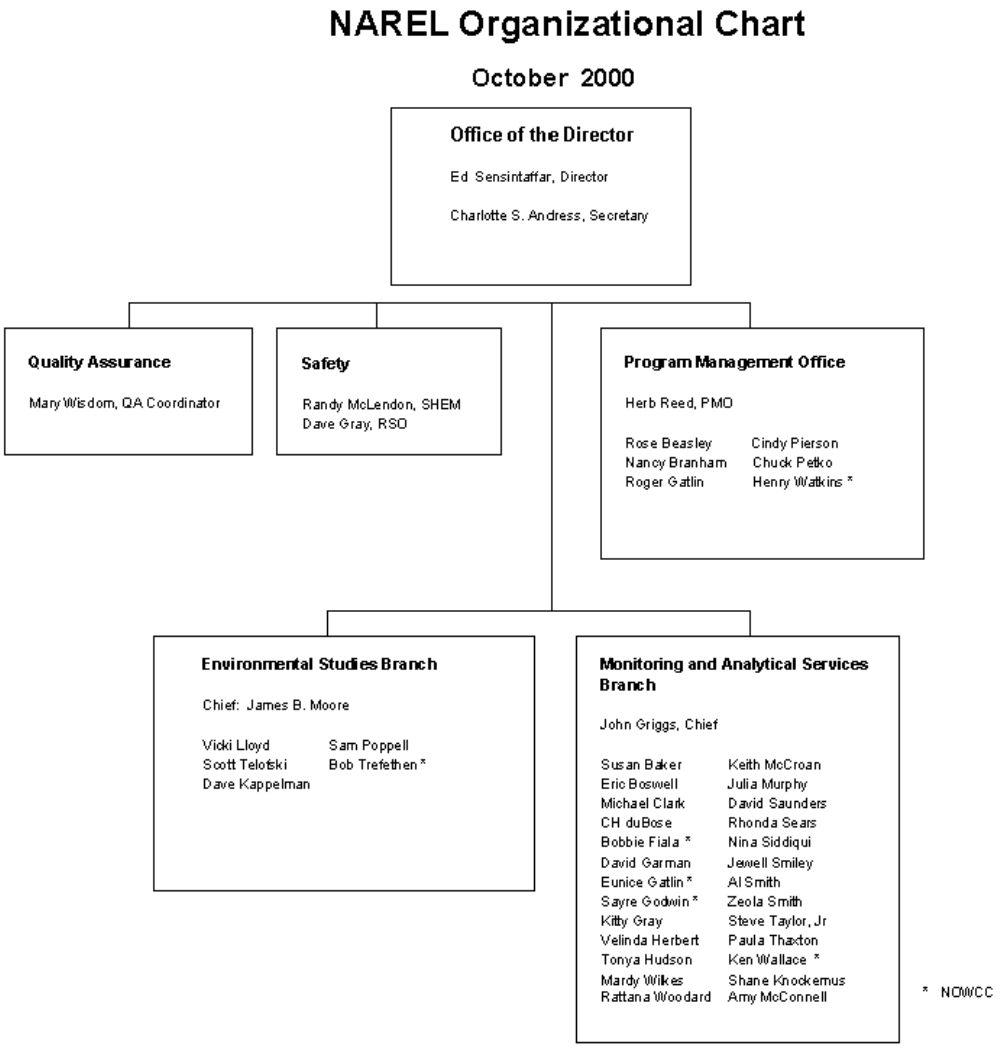

Figure 3-1 NAREL Organization Chart

3.2 Responsibilities

3.2.1 Laboratory Director

The ORIA Director has delegated to the Laboratory Director the primary responsibility for the laboratory's measurements. The Laboratory Director discharges these responsibilities by:

- Creating a work environment in which all personnel work together to ensure that Laboratory programs produce the type and quality of results expected, and providing adequate resources to implement the Laboratory's quality system. This responsibility may not be delegated to other Laboratory staff
- Appointing a Quality Assurance Coordinator (QAC) to oversee the laboratory's quality system
- Working closely with the QAC to ensure that the quality system operates smoothly, that the Quality Management Plan is implemented, and that all corrective actions are satisfactorily concluded
- Maintaining control of internal measurement programs through approval of each project plan and any new or revised standard operating procedures (SOPs)
- Maintaining control of external measurement programs through approval of the scopes of work for contracts and interagency agreements

3.2.2 Quality Assurance Coordinator

The Laboratory Director appoints a Quality Assurance Coordinator (QAC) to direct and oversee the Laboratory's quality system. The QAC has primary responsibility for quality assurance issues and the NAREL quality system. All issues concerning QA/QC must be reviewed and approved by the QAC. The QAC:

- Serves as a contact for the Laboratory Director and the ORIA Quality Assurance Manager with the Program Managers, Project Coordinators and other technical staff members
- In coordination with the Director, provides consultant services and technical assistance to the management and staff
- Assists Project Coordinators in establishing quality assurance requirements for each project administered by the Laboratory and reviews and approves QA Project Plans
- Reviews the quality of data being produced by measurement projects and recommends corrective action to the Project Coordinator as soon as the need is identified
- Performs announced and unannounced audits of NAREL systems and operations
- Reports periodically to the Laboratory Director and the OQAM on QA operations at the Laboratory

- Reviews and approves each SOP produced by NAREL
- Reviews and approves analytical data reports before release

3.2.3 MASB Chief

The MASB Chief supervises and provides direction to all other MASB employees. He or she:

- Assigns tasks to MASB personnel and monitors and evaluates job performance
- Implements training procedures to ensure the adequacy of personnel proficiency for work to be performed in MASB
- Approves by signature all procedures and plans, including SOPs, for work to be conducted by MASB personnel
- Ensures that all work within the Branch satisfies the appropriate data quality objectives (DQOs) and measurement quality objectives (MQOs), which determine the level of QA commensurate with the intended use of the results of the work
- Assigns responsibility within MASB for corrective action and approves completed corrective action reports (CARs)
- Reviews and approves each SOP produced by MASB
- Reviews and approves radioanalytical data reports before release

3.2.4 MASB Quality Assurance Officer

The MASB Quality Assurance Officer has responsibilities for quality assurance delegated by the Branch Chief. Specifically, the QA Officer:

- Maintains the MASB corrective action system
- Coordinates the production and revision of radioanalytical SOPs within MASB
- Reviews and approves each radioanalytical SOP produced by MASB
- Reviews radioanalytical data reports before release
- Reviews and approves PE and cross-check results before reporting
- Inspects radiochemistry logbooks
- Advises the MASB Chief about radioanalytical data quality issues
- Applies statistical quality control to radioanalytical instruments and procedures.

3.2.5 Radioanalytical Project Coordinator

The Radioanalytical Project Coordinator (RPC) is an employee selected by the MASB Chief to track the status of all radioanalytical projects, to coordinate data package production and review, and to advise the MASB Chief of issues related to workload and deadlines. The RPC:

- Is briefed by the MASB Chief about project background information, priority, and completion deadlines before samples arrive
- Enters project information into the laboratory information management system (LIMS)
- Communicates project information to other staff members
- Monitors the status of work on radioanalytical projects and gives periodic status reports to the MASB Chief
- Performs a second review of analytical results after the initial review and storage in the LIMS
- Coordinates the preparation and shipping of radioanalytical data reports
- Performs a preliminary review of each radioanalytical data report

3.2.6 Counting Laboratory Manager

The Counting Laboratory Manager is the primary point of contact for Counting Laboratory issues. He or she:

- Reviews and approves radioanalytical project request forms
- Monitors counting instrument functionality and coordinates maintenance
- Schedules and coordinates instrument calibrations
- Inspects Counting Laboratory logbooks and control charts
- Is the property custodial officer for most Counting Laboratory equipment

3.2.7 Counting Laboratory Data Reviewers

The Counting Laboratory Manager designates individuals in the Counting Laboratory to review data obtained from the laboratory's radiation counters and associated software. Typically, each instrument type is assigned to one data reviewer, who is expected to be knowledgeable about the instrument and analyses that involve it. The responsibilities of the data reviewer are listed below.

- Review analytical data for correctness

- Use analytical software to calculate analyte concentrations, add comments and qualifiers,
  and store results in the LIMS

- Inform the appropriate analysts and the Counting Laboratory Manager when significant problems are discovered during the review process

3.2.8 Counting Laboratory Technicians

The MASB Chief appoints individuals to serve as technicians in the Counting Laboratory. The Counting Laboratory Manager assigns responsibilities for particular instrument types to the technicians. The responsibilities of the technician are listed below.

- Receive prepared samples and documentation from the analyst

- Operate the assigned counting instruments and perform data entry

- Perform routine quality control (QC) checks on instruments

- Notify the Counting Laboratory Manager when QC problems are discovered

- Maintain instrument logbooks and control charts

- Make samples available to the analyst when they are no longer needed in the Counting Laboratory

3.2.9 Sample Preparation Laboratory Manager

The Sample Preparation Laboratory Manager (SPM) is the primary point of contact for Sample Preparation Laboratory issues. He or she performs many of the job functions of the Sample Preparation Laboratory Technicians (see below) but also has the following responsibilities.

- Reviews and approves analytical project request forms

- Receives and inspects samples

- Documents any shipping or chain-of-custody problems

- Directs the work of the Sample Preparation Laboratory technicians

- Monitors the functionality of laboratory equipment and coordinates maintenance

- Informs the MASB Chief of Sample Preparation Laboratory workload and technical issues

3.2.10 Sample Preparation Laboratory Technicians

Sample Preparation Laboratory Technicians perform their duties with direction from the SPM. The technicians have the following responsibilities.

- Assign IDs to samples
- Enter sample information into the LIMS
- Perform initial preparation of samples before sub-sampling and analysis
- Provide sample information to radiochemists
- Prepare samples for gamma analysis
- Store and dispose of samples after completion of analyses

3.2.11 Radiochemists/Analysts

The MASB Chief assigns areas of responsibility to analysts (radiochemists). Each analyst receives specialized training in the particular analyses he or she is required to perform and must be certified for those analyses before being allowed to analyze a client's samples (see MAS/SOP-10).

The analyst has the following responsibilities.

- Group samples into preparation batches for analysis
- Chemically prepare laboratory samples for radiation counting measurements, performing activities such as subsampling, digestion, separation, extraction, and precipitation
- Coordinate activities with the technicians in the Counting Laboratory, who perform radiation counting measurements
- Record analysis information in laboratory notebooks
- Compile sample and analysis documentation and provide it to the RPC when complete

3.2.12 Hazardous Waste Officer

The NAREL Hazardous Waste Officer has the following responsibilities:

- Segregate hazardous wastes into compatible products (e.g., organics and flammables, acids from bases, and mixed waste from hazardous waste, such as PCBs and pesticides)

- Prepare manifests for shipping hazardous wastes
- Provide satellite locations and storage locations of hazardous waste with proper containers for these activities
- Keep an inventory of the hazardous waste sheets once the waste is put into the storage area for shipping
- Label each storage drum with a hazardous waste label and fill out the label fully once hazardous waste is transferred to the containers in the shipping location
- Keep a permanent record of all shipments in order to be in compliance with “cradle-to-grave” regulations

3.2.13 Radiation Safety Officer

The responsibilities of the NAREL Radiation Safety Officer (RSO) are specified in the *NAREL Radiation Safety Manual*. These responsibilities include, but are not limited to, the following:

- Provide annual radiation safety training to all radiation workers at NAREL
- Process all NRC materials license applications, amendments, and renewal requests
- Monitor radiological practices to assure regulatory compliance
- Process procurement requests for radionuclides and radioactive materials
- Receive all shipments of radionuclides, equipment, and other radioactive materials and deliver or supervise delivery to the individuals named on the purchase request
- Ensure that proper safeguards are in place for the installation of radiation-generating equipment
- Maintain employee radiation exposure records
- Perform quarterly laboratory surveys for radioactive contamination and exposure rates
- Supervise all low-level radioactive waste disposal operations at NAREL
- Supervise decontamination of personnel, areas, and equipment involved in radiological accidents
- Maintain the current inventory of NRC-licensed material

3.2.14 ERAMS Manager

The ERAMS Manager is selected by the MASB Chief and is responsible for coordinating overall operations of the Environmental Radiation Ambient Monitoring System (ERAMS). The ERAMS Manager routinely informs the MASB Chief of system operations and has the following duties.

- Coordinate routine and emergency sampling operations
- Inform EPA Regional ORIA Program Managers of ERAMS activities
- Maintain and revise the ERAMS Collector's Manual
- Revise ERAMS-related SOPs as necessary
- Coordinate interagency research projects involving ERAMS samples
- Review Environmental Radiation Data (ERD) reports and develop schedules for review and dissemination of ERAMS data

3.2.15 LIMS Administrator

The LIMS Administrator is the NAREL employee who maintains the NAREL Laboratory Information Management System (LIMS). The responsibilities of the LIMS Administrator are listed below.

- Maintains the data table structures and software for the NAREL LIMS
- Authorizes users of the LIMS
- Maintains the LIMS User's Manual and other LIMS documentation

3.3 HEALTH AND SAFETY

3.3.1 General Health and Safety Criteria

Laboratory safety rules are matters of common sense and second nature to a trained chemist. However, it is the responsibility of supervisors and management to provide opportunity and training for laboratory personnel to familiarize themselves with the safety rules and equipment, so that accidental injury or damage to property does not occur. Personnel can prevent most laboratory accidents by using common sense, following the safety guidelines, taking time, and asking questions when unsure. The purpose of these safety procedures is to present the safety rules in an organized manner, and to point out some particular laboratory hazards. The following sections cover general safety procedures for NAREL. More information can be found in the *NAREL Chemical Hygiene Plan*, the *NAREL Radiation Safety Manual*, and the QMP.

3.3.2 Food, Beverages, and Smoking

No eating or drinking is allowed in lab areas. Since NAREL is a smoke-free facility, smoking is allowed only outside the building. Food and beverages are allowed only in offices and the break room. The break room is equipped with a refrigerator for FOOD ONLY. **NO** chemicals or samples are placed in this area. "No Smoking" signs are posted at all laboratory entrances as reminders.

3.3.3 Ventilation

Proper ventilation is crucial to good laboratory health. The following rules apply to all lab personnel:

- Toxic and noxious chemicals and samples must be handled under a hood.
- All hoods are for working. Hood areas are not to be used for chemical storage without the explicit approval of the MASB Chief, the NAREL Safety, Health and Environmental Manager (SHEM), and, if appropriate, the NAREL Radiation Safety Officer (RSO).
- All laboratory hoods are considered explosion proof.
- All laboratories are under negative pressure. This means the lab doors must be kept closed.
- A vaneometer is used quarterly to measure hood velocity and to ensure that the hoods are working properly, i.e., 100-150 fpm at the face. Air flow measurements document any problems on the face of the hood.
- Analysts exercise caution when using a hood. All work is performed 6 to 10 inches inside the face of the hood to prevent the escape of vapors into the lab area.

3.3.4 Clothing and Personal Items

Lab coats must be worn in the lab areas. Lab coats are not to be worn in the break room or in office areas.

3.3.5 Laboratory Facility

The main office, laboratory offices, break room, and reception area are clean areas. Under **no** circumstances are chemicals, samples, or contaminated glassware brought into these areas. All samples come through the lab sample receiving area. All supplies are delivered through the warehouse or the sample receiving area. Door bells are available at these entrances to alert lab staff to the presence of delivery personnel. Gas cylinders are kept in the tank room. All cylinders are chained, whether empty or full. Each cylinder is tagged to indicate its status (empty or full).

3.3.6 Safety Equipment

Fire extinguishers, safety showers, and eye wash stations are located throughout the laboratory. Analysts are trained in their location and use.

The building is equipped with fire and smoke detectors. The fire alarm system is also tied directly to the Maxwell/Gunter fire department.

3.3.7 Physical Examinations

All lab analysts undergo yearly physical examinations to monitor health effects. These data are evaluated by EPA's physician, and employees are notified of any problems. Corrective action decisions are then made by the physician, the employee, and management.

The rules described above are very basic, but extremely important. If analysts have questions or concerns, they contact their supervisor or the laboratory director.

3.3.8 Good Laboratory Practices

A number of SOPs are in place to guide lab personnel in the use of generally accepted Good Laboratory Practices. These include but are not limited to:

- General Health and Safety
- Document Control
- Analytical Methods
- Calibration of Balances
- Monitoring of Equipment
- Glassware Preparation
- Sample Disposal
- Waste Disposal
- Training Program

Section 6.0 contains a complete list of SOPs currently used in the MASB radiochemistry program.

4.0 ERAMS SAMPLE COLLECTION PROCEDURES

4.1 ERAMS Sampling Programs

ERAMS consists of four sampling programs which sample the nation's air, precipitation, drinking water and milk. The sampling programs together comprise over 200 environmental radiation sampling sites throughout the US.

ERAMS routinely monitors environmental levels of radioactivity in air by sampling and analyzing air particulates two times per week, precipitation as measurable amounts occur, and drinking water and pasteurized milk on a quarterly basis throughout the year. All station operators are volunteers and utilize the *Environmental Radiation Ambient Monitoring System Manual* (EPA 520/5-84-008) to collect, prepare and ship environmental samples via the US Postal Service to NAREL for analysis.

When elevated levels of radioactivity are anticipated or known to exist, ERAMS station operators may be requested to increase the sampling frequency. Such requests are made by appropriate NAREL staff familiar with the daily operations of the system. The duration and frequency of sample collections are specified at the time of the request to the station operators. Samples collected during alert (non-routine) operations are shipped via Federal Express with next morning delivery to the NAREL to decrease sample transport time.

Appendix 14.1 contains lists of ERAMS sampling locations by media and EPA region. Table 4.1 below lists the number of ERAMS sampling stations by media, number of stations, sample type and sampling frequencies.

Table 4.1 ERAMS SAMPLING STATIONS

MEDIA	NUMBER OF STATIONS	SAMPLE TYPE	SAMPLING FREQUENCY
AIR PARTICULATES	52	4" (10 cm diameter) AIR FILTER COLLECTION BY HI-VOL AIR PARTICULATE SAMPLER	TWICE WEEKLY
PRECIPITATION	38	PRECIPITATION	AS OCCURS/COMPOSITED AT NAREL INTO MONTHLY COMPOSITES
DRINKING WATER	77	GRAB TAP WATER SAMPLE	QUARTERLY
PASTEURIZED MILK	47	COMPOSITE SAMPLE REPRESENTING >80% OF MILK CONSUMED IN MAJOR POPULATION CENTERS	QUARTERLY

The ERAMS Station Collector's Manual contains station information such as collector's name, address, contact numbers, etc. and is used by sample preparation technicians in the everyday operation of the program and by the ERAMS Manager to correspond with the station operators. In the event of an emergency, information from the ERAMS Station Collector's Manual is used to notify station operators of

alert sampling conditions. A copy of the ERAMS Station Collector's Manual is kept in the sample preparation laboratory and a copy is kept by the ERAMS Manager. The ERAMS Manager is responsible for maintaining and keeping the ERAMS Station Collector's Manual current.

4.2 AIR PARTICULATE SAMPLING PROGRAM

The ERAMS air stations are located in major population centers and utilize continuously operating hi-volume air samplers. Filters from air samplers are changed twice weekly and field estimates are made with a G-M survey meter. NAREL is responsible for maintaining all air particulate collection equipment and supplies to operate the station. Replacement equipment and supplies are provided by NAREL on receipt of the ERAMS Equipment and Supply Request form (see Appendix 14.2).

Section 1.7 of the *ERAMS Manual* (EPA 520/5-84-008) describes in detail the standard operating procedure utilized for collecting an air particulate sample. Section 2.0 describes the standard procedure for making a field estimate of the gross beta activity on the collected filter. The gross beta field estimate is made 5 hours after the filter has been removed from the sampler to allow for decay of naturally-occurring radioactive gas. In the event of an elevated gross beta field estimate, station operators immediately contact the NAREL and the reading is further investigated.

The ERAMS Air and Precipitation Report (see Appendix 14.3) is submitted with each air filter collected and sent to NAREL. Detailed instructions for completing the report, along with an example, can be found in Section 3.2 of the *ERAMS Manual (EPA 520/5-84-008)*. The ERAMS Air and Precipitation Report is used for routine monitoring as well as alert (non-routine) monitoring.

4.3 PRECIPITATION SAMPLING PROGRAM

Precipitation is collected in major population centers as it occurs and when a measurable amount (>2 L) has been collected, it is sent to NAREL. All precipitation sampling stations are collocated with ERAMS air particulate sampling stations. The standard operating procedure utilized for precipitation collection is found in Section 5.7 of the *ERAMS Manual* (EPA 520/5-84-008). NAREL is responsible for providing equipment and supplies to the station operator for precipitation collection and equipment. Station operators request supplies by using the ERAMS Equipment and Supply Request form (see Appendix 14.2) used for requesting air particulate supplies. The Air and Precipitation Report used for air particulate sampling is also used for reporting precipitation collection data (see Appendix 14.3).

4.4 DRINKING WATER SAMPLING PROGRAM

Drinking water samples are collected from finished water supplies serving major population centers. NAREL ships drinking water sampling supplies directly to the station operator on a quarterly basis for sample collection. NAREL is responsible for supplying drinking water supplies and station operators can telephone the Sample Preparation Manager or ERAMS Manager to request sampling supplies if needed. Detailed standard operating procedures for collecting drinking water is located in Section 6.4 of the *ERAMS Manual* (EPA 520/5-84-008). The ERAMS Drinking Water Report is used for reporting drinking water collection data (see Appendix 14.4).

4.5 PASTEURIZED MILK SAMPLING PROGRAM

Pasteurized milk is collected on a quarterly basis. The weighted-composite samples represent > 80% of the milk consumed in each major population center sampled. Weighting and compositing of the sample is accomplished by first determining the daily volume of milk produced by each dairy plant that supplies the sample population. The volumes (or weights) for the individual dairy plants are added to yield the total milk supply for the population served. Beginning with the largest, the dairy plants which supply 80% of the total milk supply are selected to be sampled. Milk from these selected dairy plants is composited into a 3.5 liter sample based on the ratio of that plant's contribution to the total milk represented. Section 8.4 of the *ERAMS Manual* gives an example of the milk collection procedure. NAREL ships the station operators milk sampling supplies on a quarterly basis for sample collection. Station operators can telephone the Sample Preparation Manager or the ERAMS Manager to request sampling supplies if needed. The ERAMS Pasterurized Milk Report is used for reporting milk collection data (see Appendix 14.5).

5.0 SAMPLE TRACKING, CUSTODY AND DISPOSAL

5.1 Sample Receipt

The receipt of ERAMS samples for radioanalysis are described in the *NAREL Standard Operating Procedure for Receipt, Log-in, and Storage* of Environmental Samples (MAS/SOP-14).

All ERAMS samples are received by the Sample Preparation Manager or Sample Preparation Laboratory Technicians. At the time of sample receipt, the following steps are taken:

- ERAMS samples are not surveyed upon receipt (see the *NAREL Radiation Safety Manual*, Appendix B).
- Samples arrive via the US Postal Service on a routine basis and via Federal Express during alert (non-routine) sampling conditions. The sampling containers are opened and visually inspected upon receipt. Any samples requiring special attention are reported to the ERAMS Manager.
- Samples are assigned a unique sample ID number and logged into the appropriate ERAMS Sample Preparation Logbook, recorded on the sample container and sample data sheet and then entered into the NAREL Laboratory Information Management System (LIMS).
- Documentation received with ERAMS samples is kept on file in the Sample Preparation Laboratory.

5.2 Sample Tracking

Samples are assigned laboratory sample numbers from a logbook in the Sample Preparation Laboratory upon arrival and are then entered into the NAREL laboratory information management system (LIMS). The sample number has the form *yy.nnnnnx*, where *yy* denotes the 2-digit year in which the sample was received, *nnnnn* denotes a sequential number, and *x* is an alphabetic checksum character used to prevent data entry errors. (For the years 2000 and beyond, the *yy* code begins with the letter “A.” E.g., A0 = 2000, A1 = 2001, etc.) The checksum is not written in the Sample Preparation Logbook, because its value is unknown until the sample record is created in the LIMS.

All reference to a sample is made using the NAREL laboratory reference number. The laboratory reference number affixed to each sample is unique to that sample. Samples are processed through the laboratory by the laboratory reference number. Laboratory worksheets generated for each project are also filled out by analysts to track sample analysis.

The system for tracking samples through preparation and analysis consists of chain-of-custody records, laboratory worksheets, laboratory notebooks, instrument operation logbooks, instrument printouts (raw data), and final analytical reports. This tracking system ensures that the laboratory's records can be used as valid evidence should such data become the subject of testimony.

5.3 Sample Custody

Special consideration must be given to the storage and transportation of samples to be analyzed. Procedures should ensure that any analyte originally present in the sample matrix has not undergone degradation or concentration, and that contaminants which might interfere with the analysis have not been added. Any error in documentation is deleted with one line drawn through the error. Corrections are initialed and dated.

5.3.1 Criteria for Custody

Once samples are received in the laboratory, they are placed in a secure storage area to which only laboratory personnel have access. A sample is considered to be in custody at NAREL if one of the following is true:

- It is in an analyst's possession
- It is in the analyst's view after being in his or her physical possession
- It is in a secure area

5.3.2 Sample Chain-of-Custody

Samples are physical evidence and are handled according to certain procedural safeguards. In some types of legal proceedings, a showing to the court that the laboratory is a secure area may be all that is required for the analyzed evidence to be admitted. However, in some cases, a court may require a showing of the hand-to-hand custody of the samples while they were at the laboratory. In the event that the court requires such a comprehensive chain-of-custody demonstration, the laboratory must be prepared to produce documentation that traces the in-house custody of the samples from the time of receipt to completion of the analysis. For certain projects, documentation of in-house chain of custody is a routine requirement.

5.4 Provisions for Sample Security

To satisfy these custody provisions, NAREL implements the following procedures:

- Samples are stored in a secure area.
- Access to the laboratory is restricted. Exterior entrances and entrance to the sample preparation area require a coded key for entry. Entry into the sample receipt area is monitored by sample preparation staff.
- Visitors must sign in at the reception area and are escorted while in the laboratory.
- Samples remain in the secure storage area until they are removed for sample preparation or analysis.
- After a sample has been removed from storage by the analyst, the analyst is responsible for the custody of the sample.

5.5 Sample Storage

After the samples are logged in and numbered, and all documentation is complete, samples are stored at various locations throughout NAREL, depending on the matrix, analyses requested, and project, until the analyses are performed. The procedures are described the *NAREL Standard Operating Procedure for Sample Receipt, Log-in, and Storage of Environmental Samples* (MAS/SOP-14).

5.6 Disposal of Samples, Extracts, and Digestates

Proper disposal of samples is necessary to insure that laboratory storage space is used at greatest efficiency, and that samples containing hazardous or toxic substances are safely stored and disposed of. The Hazardous Waste Officer and the Radiation Safety Officer are responsible for proper disposal of samples, extracts, and digestates.

5.7 Disposal of Non-Hazardous Samples

Samples which are not determined to contain hazardous or toxic substances are disposed of according to NAREL procedures for disposal of non-hazardous samples.

6.0 ERAMS SAMPLE ANALYSES

6.1 Sample Preparation

ERAMS samples are prepared for radiochemical analysis by Sample Laboratory Technicians using the procedures contained in the *NAREL Standard Operating Procedure for Preparation of Environmental Samples for Radiochemical Analysis* (MAS/SOP-15).

6.2 Sample Analyses

Table 6.1 lists the specific analyses performed on ERAMS samples, as well as the analytical frequency for ERAMS samples.

Table 6.1 ERAMS SAMPLE ANALYSES

MEDIA	ANALYSIS	ANALYTICAL FREQUENCY
AIR PARTICULATES	5-HR GROSS β FIELD ESTIMATE	TWICE WEEKLY
	GROSS β - NAREL	TWICE WEEKLY
	GAMMA SCAN	ALL SAMPLES SHOWING GROSS β > 1pCi/m^3
PRECIPITATION	H-3	MONTHLY COMPOSITE SAMPLES
	GROSS β	MONTHLY COMPOSITE SAMPLES
	GAMMA	MONTHLY COMPOSITES WITH GROSS β > 1 pCi/m^3
DRINKING WATER	H-3	QUARTERLY
	GROSS α, GROSS β, SR-90, GAMMA	ANNUAL COMPOSITES
	RA-226	ANNUAL COMPOSITES WITH GROSS α > 2 pCi/L
	RA-228	ANNUAL COMPOSITES WITH RA-226 BETWEEN 3-5 pCi/L.
	I-131	QUARTERLY SAMPLE ONCE PER YEAR PER STATION
	PU-238, -239, -240, U-234, -235, -238	SAMPLES WITH GROSS α > 2 pCi/L
PASTEURIZED MILK	I-131, BA-140, CE-137, K-40	QUARTERLY
	SR-90	JULY SAMPLE

6.3 Analytical Procedures

Radioanalytical Chemists adhere to the quality assurance practices outlined in the NAREL *Radiochemistry Quality Assurance Manual*. ERAMS samples are analyzed by NAREL chemists utilizing analytical procedures contained in the *National Air and Radiation Environmental Laboratory Radiochemistry Procedures Manual*.

The methods routinely used for radiochemical analyses are listed below.

- NAREL Am-01 Americium-241 in Environmental Matrices
- NAREL Gam-01 Gamma Spectrometry on Environmental Matrices
- NAREL Gr-01 Gross Alpha and Beta on Water Samples
- NAREL Gr-03 Gross Alpha and Beta on Solid Samples
- NAREL H-01 Tritium in Environmental Matrices
- NAREL H-02 Tritium in Water
- NAREL H-04 Tritium in Silica Gel
- NAREL I-01 Iodine-131 in Water
- NAREL Po/Pb-01 Polonium-210 and Lead-210 in Environmental Matrices
- NAREL Pu-01 Plutonium-238 and -239 in Environmental Matrices
- NAREL Pu-02 Plutonium-238 and -239 by Leaching, Soil and Sediment
- NAREL Ra-01 Preparing Solid Samples for Radium-226 and Radium-228 Analysis
- NAREL Ra-03 Preparing Water Samples for Radium-226 and Radium-228 Analysis
- NAREL Ra-04 Radium-226 in Environmental Matrices
- NAREL Ra-05 Radium-228 in Environmental Matrices
- NAREL Sr-02 Strontium-89 and -90 in Milk
- NAREL Sr-04 Strontium-89 and -90 in Environmental Matrices
- NAREL U/Th-01 Isotopic Uranium and Thorium in Environmental Matrices

NAREL also analyzes air filters for gross beta activity using the procedures described in the *NAREL Standard Operating Procedure for Calibration and Use of the G5000 Proportional Counting System* (RAL/SOP-8). ERAMS reporting increments and minimum detectable concentrations (MCDs) are listed in Appendix 14.6.

- Other SOPs Used in Radiochemistry

MAS/SOP-1 *NAREL SOP for Chain of Custody*
MAS/SOP-2 *NAREL SOP for Calibration and Use of Balances*
MAS/SOP-3 *NAREL SOP for Cleaning Glassware and Planchets*
MAS/SOP-4 *NAREL SOP for Operating and Maintaining Fume Hoods*
MAS/SOP-5 *NAREL SOP for Use and Maintenance of Laboratory Logbooks*
MAS/SOP-6 *NAREL SOP for Calibration and Use of pH Meters*
MAS/SOP-7 *NAREL SOP for Labeling Chemical Containers*
MAS/SOP-8 *NAREL SOP for Storing Chemicals and Solutions*
MAS/SOP-9 *NAREL SOP for Transporting Chemicals*
MAS/SOP-10 *NAREL SOP for Training and Certification of Laboratory Personnel*

MAS/SOP-11	*NAREL SOP for Preparing Alpha Spectrometry Efficiency Standards*
MAS/SOP-12	*NAREL SOP for Preparing Thorium-234 Tracer Solutions*
MAS/SOP-13	*NAREL SOP for Preparing Uranium-234 Tracer Solutions*
MAS/SOP-14	*NAREL SOP for Sample Receipt, Log-in, and Storage of Environmental Samples*
MAS/SOP-15	*NAREL SOP for Preparation of Environmental Samples for Radiochemical Analysis*
MAS/SOP-16	*NAREL SOP for Calibration and Use of Pipets*
MAS/SOP-17	*NAREL SOP for the Use of Control Charts*
MAS/SOP-18	*NAREL SOP for the Review of Radiochemistry Data*
RAL/SOP-1	*NAREL SOP for Calibration and Use of High-Purity Germanium Detectors*
RAL/SOP-2	*NAREL SOP for the Handling of P-10 Gas*
RAL/SOP-3	*NAREL SOP for Calibration and Use of the LB4000 Multi-counting System*
RAL/SOP-4	*NAREL SOP for Calibration and Use of Alpha Spectrometers*
RAL/SOP-5	*NAREL SOP for the Handling of Liquid Nitrogen*
RAL/SOP-6	*NAREL SOP for Calibration and Use of the Random SC-5 Scintillation Counter*
RAL/SOP-7	*NAREL SOP for Calibration and Usage of the G3000 Automatic Gamma Analysis System*
RAL/SOP-8	*NAREL SOP for Calibration and Use of the G5000 Proportional Counting System*

7.0 LABORATORY INFORMATION MANAGEMENT

7.1 Data Base

MASB maintains a computer data base of information about radiochemical analyses performed on ERAMS samples at the laboratory. Each sample is identified by a unique sample number. For each sample MASB records the following items of information:

- Sample number
- Project ID (ERAMS)
- Sample matrix
- Sample size (volume or mass) and units
- Collection date(s) and time(s)
- Sampling location
- Date of receipt at NAREL

At the time the sample record is created, data base entries are also made for all required analyses. Whenever possible, raw analysis data are captured and manipulated automatically by software interfaced directly to the analysis equipment. Analytical results are printed for review but entered automatically into the LIMS data base. Manual data entry of results by a computer operator is allowed, but only when absolutely necessary. All results entered manually must be independently checked by a person other than the operator who enters the data.

For each radiochemical analysis, MASB records the following information:

- Unique analysis number, assigned automatically by the LIMS
- Analytical procedure ID
- Analyst ID
- Counting system(s)
- Counting date(s), time(s), duration(s)
- Instrument operators
- Reviewers and dates of review
- Result(s)

For each analytical result, the following information is recorded:

- Analyte ID
- Measured activity, concentration, or amount
- Estimated measurement uncertainty (one standard deviation)
- Decision level concentration (DLC), also called “critical concentration”
- Sample-specific minimum detectable concentration (MDC)
- Unit of measure
- Effective date of measurement (for decay correction)
- Software

7.2 Software

All data base systems and analytical software, including any programs used to process and store radioanalytical data, must be approved by the MASB QA Officer before use.

Commercial software that will be used for these purposes must be approved in writing by the MASB QA Officer before purchase. The software must also be evaluated and tested on site before being used for actual sample data. The QA Officer must approve the software in writing after testing.
The primary in-house software systems used by MASB include:

LIMS	LIMS main program
AirBeta	Data reduction and review for gross beta analyses of air filters
AlphaRvw	Data reduction and review for alpha spectrometry
GammaRvw	Data review for gamma analyses
ABWin	Data reduction and review for gross alpha/beta analyses
H3Rvw	Data reduction and review for tritium analyses
I131Rvw	Data reduction and review for iodine-131 analyses
Ra226Rvw	Data reduction and review for radium-226 analyses
Ra228Win	Data reduction and review for radium-228 analyses
SrWin	Data reduction and review for strontium-89 and 90 analyses

There are also a number of data-entry programs used in the Counting Laboratory to streamline the flow of data from analysts to instrument operators to data reviewers. These programs are used for the Tennelec LB4000 and Gamma Products G5000, G5400, and G542 gas-flow proportional counters and the high-purity germanium detectors. Specifically, the following instrumentation and software is used for ERAMS sample analyses:

Alpha Spec	Tennelec 256 Alpha Spec Chamber Ortec Alpha King Chambers Oxford Oasis Alpha Spec System Software: Oxford Oasis Alpha Spec System
Gross Alpha, Beta	Gamma Products G5400 Auto-Quad Alpha Beta Counting System Software: G5400 Software and NAREL's G54Enter.Exe software Gamma Products G5000 Air Beta Counting System Software: G5000 and NAREL's Air Beta software
Gamma	EG&G Ortec High Purity Germanium Detectors and Electronics Software: Quantum Technology GDR

8.0 ERAMS DATA REVIEW

8.1 Preliminary Analytical Review

Radiochemistry data review occurs during all phases of an analysis; however, there is also a formal data review process involving staff members with special responsibilities for ensuring the correctness and completeness of ERAMS generated data. A more complete description of the entire review process which applies to all ERAMS samples is contained in the *NAREL SOP for Radiochemistry Data Review* (MAS/SOP-18).

Analysts who submit information with samples to the Counting Laboratory are responsible for checking the information provided. They are also responsible for double-checking the work of the Counting Laboratory technicians when samples and analysis results are returned.

Counting Laboratory technicians are responsible for double-checking the information provided to them by the radiochemists whenever possible. If information appears questionable, the technician has the duty to contact the radiochemist for confirmation. The technician is also responsible for checking his or her own data entry before the analysis results reach the first stage of the formal "data review" process.

8.2 Analytical Review

It is MASB policy to require two *independent* formal reviews of each radiochemical analysis performed. The first review typically is done by a representative of the Counting Laboratory, and the second by the Radioanalytical Project Coordinator. One exception is tritium analysis, which does not involve the NAREL Counting Laboratory. The tritium analyst performs the first review of tritium analyses. The ID of the reviewer and the date of the review are recorded with each analysis stored in the NAREL LIMS.

The first stage of formal data review occurs at the same time the sample results are computed. The same software systems allow the reviewer to calculate and mark results as approved or disapproved. When the review is complete, the calculation/review software stores the results in the LIMS.

The second formal review occurs after the results are stored in the LIMS. The second reviewer uses the LIMS software to view the analysis information and mark the results as approved or disapproved.

All analyses involving measurements performed in the Counting Laboratory must be reviewed first by an authorized representative of the Counting Laboratory. No one may reverse a decision by the first reviewer to disapprove an analysis without a successful appeal to the Counting Laboratory Manager or the NAREL Quality Assurance Coordinator. For any analysis that does not involve the Counting Laboratory (e.g., tritium), the analyst performs the first review.

Generally only one set of results per analysis should be stored in the data base. However, if more than one analysis is performed, results from each analysis, including rejected results, should remain in the data base. Therefore:

- An analysis should never be deleted from the data base because of an error in preparation or counting. Instead, the data reviewer must mark the analysis record as disapproved and add a

comment explaining why the analysis is unacceptable.

- If the results were calculated incorrectly and later recalculated, the incorrect data should be replaced.

8.3 ERAMS Event Reports

If an ERAMS sample contains an unexpected radionuclide (e.g., ^{131}I, ^{89}Sr, gamma emitters), an unusually high level of gross alpha or beta radiation, or a high concentration of an analyte, the data reviewer must complete an ERAMS Event Report (see Appendix 15.7) and provide copies to the MASB Chief, ERAMS Manager, Counting Laboratory Manager, Radioanalytical Project Coordinator, Quality Assurance Coordinator and Quality Assurance Officer. The ERAMS Manager receives the original copy and files it. The other recipients receive photocopies.

9.0 ERAMS DATA DISSEMINATION

9.1 Environmental Radiation Data (ERD) Reports

ERAMS data are published quarterly in *Environmental Radiation Data* reports. The procedure used for reviewing ERD reports is found in Section 6.0 of the NAREL SOP for Radiochemistry Data Review (MAS/SOP-18). The RPC performs a preliminary review and submits the report to the MASB QAO for review. The ERAMS Manager reviews the report and coordinates reviews by the QAC, MASB Chief, Counting Laboratory Manager, and Sample Preparation Laboratory Manager. Once all approvals are final, the RPC submits electronic and hard-copy versions to the NAREL Publication Coordinator for dissemination.

9.2 Data Reporting Policies

9.2.1 Negative Results

Frequently, there is little or no radioactivity in environmental media. Thus, the results of laboratory analyses should show a distribution of negative and positive numbers about zero. A negative value occurs when a previously determined background value is subtracted from a sample value that is less than that of the background. From July 1975 to March 1991, ERAMS data were reported as calculated, whether the results were negative, zero, or positive. Since April 1991, negative results have been denoted as “not detectable,” or “ND.” For gamma analyses only, results less than the 2σ counting error are also denoted as “not detectable.”

9.2.2 Reported Error Terms

Each reported value for specific analyses will be accompanied by a counting error term at the 2σ (95%) confidence level. Error terms are therefore reported as counting errors. At the very low levels characteristic of most ERAMS measurements, counting error is the greatest contributor to overall error.

9.2.3 Measurement Units

Generally, activity concentrations for liquid samples are calculated in pCi/L, although certain projects may require other units. Activity concentrations for air samples are calculated in pCi/m^3. Activity concentrations for solid samples are generally calculated in pCi/gash, pCi/gdry, or pCi/gwet.

The LIMS has the capability to convert results to specified measurement units.

9.2.4 Significant Figures

The uncertainty associated with ERAMS generated data is rounded to two significant figures and the radioactivity is rounded off to the same number of decimal places.

9.2.5 Reagent Blanks

Although MASB analyzes a reagent blank with each QC batch for most analytical procedures, the results of sample analyses are not routinely blank-corrected before reporting. Sample counts are blank-

corrected only by subtracting instrument backgrounds. The reagent blank is used as a QC sample to check for contamination or other low-level bias in the measurement process. Reagent blank results are reported separately to clients, who may or may not choose to use them to perform blank corrections.

The blank analyzed with a tritium batch is not considered a “reagent blank.” The result for the tritium blank is used instead of an instrument background measurement for blank-correction of sample results.

10.0 ANALYTICAL QUALITY CONTROL

10.1 Quality Control Batches

Analyses are grouped into batches for QC purposes. The LIMS automatically assigns a batch number when the QC batch record is defined. The batch number serves to associate QC results with samples at the time of reporting. A QC batch consists of at most 20 samples, excluding the QC samples. A QC batch ordinarily comprises all the analyses of one type performed on a single sample delivery group.

Three types of quality control samples are analyzed routinely. The QC analyses and their frequency are:

- laboratory duplicate (one per QC batch);
- matrix spike or lab control sample (one per QC batch); and
- reagent blank (one per QC batch).

The batch QC requirements listed above do not apply to gamma or gross alpha and beta analyses which comprise the majority of ERAMS analysis. For gamma analysis, one laboratory duplicate is analyzed per QC batch, and in-house performance evaluation (PE) samples are occasionally submitted by the NAREL quality assurance staff. One laboratory duplicate analysis is performed with each gross alpha/beta QC batch. For gross beta analysis of air filters, a minimum of one duplicate is analyzed with each twenty filters.

The QC requirements for tritium analyses are similar to those listed above, but the blank is evaluated differently and is therefore referred to as a “tritium blank” and not as a reagent blank.

The result of a quality control check is a quality indicator, whose numerical value must be judged either acceptable or unacceptable. The acceptance criteria for a quality indicator must be based on statistical principles and should be formulated in terms of the estimated standard deviations (standard uncertainties) of the quantities used to compute the value of the indicator.

A quality indicator may have both control limits and warning limits. The purpose of a warning limit is to give a warning of a potential or developing problem. If several measurements fall in the warning region, an investigation into the cause may be required. When a value is outside the control limits, an investigation is always required, and corrective action may also be necessary.

10.2 Preparation Batches

Analyses performed together by an analyst constitute a preparation batch, or “prep” batch. Analysts use the LIMS to define each preparation batch and to obtain a preparation batch form, which lists the samples in the batch, project IDs, and collection dates and times, and provides blank columns for other required analysis information. A preparation batch may or may not coincide with a QC batch.

Counting measurements in the Counting Laboratory are scheduled by preparation batch. The analyst completes blank columns of the preparation batch form as appropriate and delivers the form with the prepared samples to the Counting Laboratory for counting.

The Counting Laboratory returns the original preparation batch form to an analyst after all the sample results are reviewed. Both the analyst and the instrument operator initial the form and document any problems on the reverse side.

10.3 Acceptance Criteria for Quality Control Analyses

10.3.1 Duplicate Analyses

When precision is assessed by a laboratory duplicate analysis, the quality indicator is given by the following "*Z* score." For ERAMS, this applies only to gross alpha and beta, tritium and the occasional samples which require nuclide-specific analyses.

$$Z_d = \frac{S_2 - S_1}{\sqrt{u^2(S_1) + u^2(S_2)}},$$

where

S_1	=	First of two measurements
S_2	=	Second of two measurements
$u(S_1)$	=	Standard uncertainty of S_1
$u(S_2)$	=	Standard uncertainty of S_2

MASB routinely reports the "relative percent difference," or *RPD*, of the two measurements, which is defined by the equation

$$RPD = \frac{|S_2 - S_1|}{(S_1 + S_2)/2} \times 100\%.$$

MASB does not use the RPD to evaluate laboratory duplicates.

When the total measurement uncertainties $u(S_i)$ for the measured concentrations S_i are unknown, they are estimated using the equation

$$u^2(S_i) = E_i^2 + \eta^2\left(\frac{S_1 + S_2}{2}\right)^2$$

where

E_i	=	Counting uncertainty of S_i
η	=	Maximum acceptable excess relative standard uncertainty

For a list of η values for various analyses, see Table 1.1.

The warning limits for Z_d are ±2, and the control limits are ±3. Warning limits are used for subjective evaluation only.

10.3.2 Spiked Samples

For ERAMS analyses, spiked samples are used for tritium analysis and the occasional nuclide specific analyses. Generally, activities for spiked samples, including both matrix spikes and laboratory control samples, are computed in concentration units (e.g., PCI/L or PCI/GASH).

In the case of a matrix spike, the quality indicator is defined as

$$Z_r = \frac{S - B - K}{\sqrt{u^2(S) + u^2(B) + u^2(K)}},$$

where

S	=	Measured concentration in spiked aliquot
B	=	Measured concentration in unspiked aliquot
K	=	Known concentration of spike added
$u(S)$	=	Standard uncertainty of S
$u(B)$	=	Standard uncertainty of B
$u(K)$	=	Standard uncertainty of K

The uncertainties $u(S)$ and $u(B)$ may be estimated as follows:

$$u^2(S) = E_s^2 + \eta^2 S^2,$$
$$u^2(B) = E_b^2 + \eta^2 B^2,$$

where

E_s	=	Counting uncertainty of S
E_b	=	Counting uncertainty of B
η	=	Maximum acceptable excess relative standard uncertainty

The quality indicator for laboratory control samples and PE samples is defined as

$$Z_r = \frac{S - K}{\sqrt{u^2(S) + u^2(K)}},$$

where

S	=	Measured concentration of reference material
K	=	Known concentration of reference material
$u(S)$	=	Standard uncertainty of S
$u(K)$	=	Standard uncertainty of K

The uncertainty $u(S)$ may be estimated as follows:

$$u^2(S) = E_s^2 + \eta^2 K^2,$$

where

E_s = Counting uncertainty of S
η = Maximum acceptable excess relative standard uncertainty

It is permissible to use a fixed percentage of K, not to exceed 5%, for $u(K)$. If the uncertainty in K is assumed to be negligible, then $u(K)$may be set equal to zero.

The warning limits for Z_r are ±2, and the control limits are ±3. Warning limits are used for subjective evaluation only.

MASB routinely reports the "percent recovery," or %R, which is given by

$$\%R = \frac{S - B}{K} \times 100\%$$

for matrix spikes and by

$$\%R = \frac{S}{K} \times 100\%$$

for performance spikes and standard reference materials. MASB does not use %R to evaluate spike results.

Table 10.1
Eta Values (η)*

Analysis	Analyte	Eta (η)
Gross Alpha/Beta	Alpha	0.10
	Beta	0.075
Gamma	All	0.05
Iodine	^{131}I	0.05
Plutonium	^{238}Pu, ^{239}Pu	0.05
Radium-226	^{226}Ra	0.05
Radium-228	^{228}Ra	0.075
Strontium	^{89}Sr,^{90}Sr	0.05
Thorium	^{227}Th,^{228}Th,^{230}Th,^{232}Th	0.05
Uranium	^{234}U,^{235}U, ^{238}U	0.05

* Values in use as of March 9, 2001

10.3.3 Reagent Blanks

Reagent blank activities are computed in total activity units, not as concentrations.

A reagent blank control chart is maintained for each nuclide-specific method, analyte, and analyst. The LIMS maintains these charts electronically, and an analyst may print a copy of the chart for any analysis type at any time.

When a reagent blank result is unacceptably high, the analyst must submit a corrective action report and investigate the cause of the problem. In this situation, the samples in the batch may require reanalysis. If it appears that the samples were mixed up or mislabeled, the entire batch should be reanalyzed.

Otherwise a decision whether to reanalyze may be made for each sample. If a particular sample result is below the level of concern, a reanalysis of that sample is usually not necessary.

A reagent blank result is unacceptably low if it is more than 3 standard deviations below zero. When a failure of this type occurs, an investigation is required. The problem in this case is likely to be associated with the radiation counting instrument or with an interference correction. Reanalysis of a sample under these circumstances is required unless the measured sample activity is much greater than the level of concern.

10.4 QC Batch Reports

Analysts should use the LIMS to produce a QC batch report for each QC batch before submitting the results to the RPC.

The analyst submits the completed QC batch report and related control charts to the MASB QA Officer. The QA Officer signs the report and returns the report and control charts to the analyst.

The analyst completes an Analyst Checklist for each QC batch and provides it to the RPC when submitting the results of a batch.

The analyst submits all raw data and calculation sheets, the preparation batch forms, reagent blank control charts, and QC batch reports. All data should be provided, including those for rejected analyses that were repeated. Rejected data must be clearly marked.

11.0 PERFORMANCE AND SYSTEM AUDITS

11.1 Introduction

Technical assessments, audits, and inspections are part of the overall Quality System and are intended to provide guidance for quality improvement, to identify problems and deficiencies, and to acknowledge what is being done well in NAREL's operations. Audits are management tools for assessment and improvement, and are not to be viewed as punitive. The technical assessments help staff evaluate how well expectations are being met and offer recognition for good practices and effective work.

11.2 Performance Evaluation and Cross-Check Samples

A performance evaluation (PE) or cross-check sample examines the ability of the laboratory to perform analytical procedures and obtain data of known and required precision and accuracy. Performance evaluation and cross-check samples are analyzed throughout the year as continual checks on accuracy and precision for all analyses. It is NAREL policy to participate in as many intralaboratory comparisons and cross-check programs as practical for analysis of radionuclides, radon, and the chemical components of mixed waste. The QA staff is also expected to provide internally prepared single-blind PE samples on a regular schedule for analytes and matrices of interest. During each calendar year, each analyst must analyze PE samples for the analytes for which he or she is certified to perform analyses.

PE and cross-check samples must be analyzed and reviewed in the same manner as regular analytical samples. PE or cross-check programs conducted by external agencies must be coordinated through the QAC and the appropriate Branch Chief. All results must be reviewed and approved by the QA staff before submitting data to any outside PE program. Results and scores received from an outside program must be reported by the outside program directly to the QA staff. The QAC or a designee compiles the results, conducts a statistical test for acceptability, and reports the results to the analysts, the Branch Chief, the Associate Director, and the Laboratory Director. Unacceptable results require an investigation, and written documentation of findings and corrective actions must be submitted to the QAC. The QA staff monitors trends in PE and cross-check results and provides an annual graphical summary of PE results to management. Performance evaluation samples are analyzed throughout the year for all parameters, as a constant check on accuracy and precision for all analyses.

11.3 Single-blind Samples

Before a new analyst is permitted to take full responsibility for an analysis, after extensive instrument maintenance or repair has been done, or when a corrective action has been required on a method, the QAC prepares a single-blind for analysis. The analytes of interest are known to the analyst, but their concentrations are not known. All single-blind analyses are reviewed, scored, and interpreted by the QAC. Results are discussed with the analyst and the supervisor as needed.

11.4 External Performance Evaluation Samples

NAREL takes part in three external performance evaluation programs, the Mixed Waste Performance Evaluation Program (MAPEP - DOE), the NIST Radiochemistry Intercomparison Program (NRIP), and the Environmental Measurement Laboratories Quality Assurance Program (EML - DOE), on a regular basis.

Samples received for several matrices and many parameters during the year, and are analyzed as single-blinds. Results are reported directly to the appropriate agency by the QAC. Incorrect results require investigation and the filing of a corrective action report with the QAC.

In addition, NAREL participates in performance evaluation studies sponsored by the World Health Organization (WHO), the International Atomic Energy Agency (IAEA) as the samples are available.

11.5 QAC Laboratory Audits

The QAC conducts at least one complete systems audit during each fiscal year. The audit must cover all aspects of NAREL's mission. The audit allows the QA staff to assess and document facilities, equipment, systems, procurement, record keeping, data validation, operations, maintenance, calibration procedures, software control, reporting requirements, and QC procedures. The audit must assess adherence to the QMP, QAM, and SOPs, generally accepted Good Laboratory Practices (GLP), and written policies for NAREL operations. An audit of data quality should be performed each year either in conjunction with the systems audit or at a different time. This audit will assess the methods used to collect, interpret, and report the information required to characterize data quality. Such an audit requires detailed review of recording and transfer of raw data, calculations, documentation procedures, and data quality indicators. Audits may be either announced or unannounced.

The QAC or a designee is required to provide documentation of the audit findings, deficiencies, and recommendations to management within one month after completion of an audit. Findings and deficiencies require investigation and implementation of corrective actions by the appropriate personnel, and require a written response to the QAC within one month of the audit report.

12.0 CORRECTIVE ACTION

12.1 The MASB Corrective Action System

Corrective action may be required when data fail to meet the predetermined limits for acceptability. MASB maintains a formal corrective action system to ensure that such problems are reported, documented, and resolved.

The MASB QA Officer coordinates the implementation of the corrective action system. He or she maintains documentation of corrective action, either completed or in progress.

Any staff member may initiate corrective action for a problem by submitting an MASB Corrective Action Report form (CAR) to the MASB QA Officer. The submitted form describes the problem and recommends short-term and long-term remedies, as appropriate. The QA Officer assigns a tracking number to the report, adds comments and recommendations, signs and dates the form, and forwards it to the MASB Chief. The MASB Chief may also add recommendations. He or she assigns the corrective action to the appropriate employee, signs and dates the form, makes photocopies of the form for the QA Officer and the QAC, and provides the original copy of the form to the person responsible for corrective action.

The person who is assigned responsibility for corrective action must document the actions taken on the back of the form, including:

- Immediate steps taken to mitigate harmful consequences
- Steps taken to investigate the problem
- Likely cause of the problem
- Corrective actions, which are expected to solve the problem and prevent a recurrence

The person then signs and dates the form and submits it to the MASB QA Officer. The QA Officer signs and dates the form and optionally adds comments. He or she keeps a photocopy of the document and submits the original to the MASB Chief, who must approve or disapprove the actions taken. If the actions are approved, the completed form is returned to the QA Officer, who files it. If the actions are disapproved, the MASB Chief returns the form to the responsible person with additional instructions. Any further steps taken may be documented on an attachment.

When a CAR is completed and filed, the QA Officer may destroy (recycle) any incomplete photocopies. A completed CAR is held until at least ten years after its date of origination.

Situations that require corrective action reports include:

- QC analysis failures (laboratory duplicates, reagent blanks, spikes)
- Cross-check and PE sample failures
- Sample mix ups by analysts or counting laboratory personnel
- Software bugs (but not proposed software *enhancements*)
- Bad laboratory practices, or any practice that has adversely affected data quality
- Any problem with data quality that has continued for a considerable length of time or that will continue because it cannot be corrected immediately

If in doubt about whether a CAR is needed, staff members should ask the QA Officer.

12.2 Corrective Action for Quality Control Samples

One of the primary means of detecting data quality problems is the routine analysis of QC samples, such as laboratory duplicates, laboratory control samples, and matrix spikes, as described in Section 10. In most cases the analyst is the first person who observes the failure of a QC analysis and therefore has the responsibility to report the problem. This fact does not necessarily imply that the analyst caused the problem or will be assigned responsibility for correcting it.

If a QC analysis fails, it is not permissible to repeat only the QC analysis unless an explanation is given for why the error that caused the failure would not affect other samples in the batch.

13.0 REFERENCES

NAREL 2001 *National Air and Radiation Environmental Laboratory Radiochemistry Procedures Manual*. Revision 0, May 23, 2001.

EPA 1988 *Environmental Radiation Ambient Monitoring System Manual* (EPA 520/5-84-008).

NAREL 2001 *National Air and Radiation Environmental Laboratory Radiation Safety Manual*. Revision 3, June 2001.

QA/QAM-1 *National Air and Radiation Environmental Laboratory Radiochemistry Quality Assurance Manual*. Revision 0, March 22, 2001.

QA/QMP-1 *National Air and Radiation Environmental Radiation Laboratory Quality Management Plan*. Revision 1, March 15, 2001.

MAS/SOP-14 *NAREL Standard Operating Procedure for Sample Receipt, Log-in, and Storage of Environmental Samples*. Revision 1, June 9, 2001.

MAS/SOP-15 *NAREL Standard Operating Procedure for Preparation of Environmental Samples for Radiochemical Analysis*. Revision 0, June 22, 2000.

MAS/SOP-18 *NAREL Standard Operating Procedure for Radiochemistry Data Review*. Revision 0, May 31, 2001.

APPENDICES

APPENDIX 14.1

ERAMS LOCATIONS

ERAMS - AIR PARTICULATE SAMPLING PROGRAM

LOCATION	REGION
1. Hartford, CT	1
2. Augusta, ME	1
3. Concord, NH	1
4. Trenton, NJ	2
5. Albany, NY	2
6. New York City, NY	2
7. Syracuse, NY	2
8. Yaphank, NY	2
9. Wilmington, DE	3
10. Harrisburg, PA	3
11. Pittsburgh, PA	3
12. Lynchburg, VA	3
13. Montgomery, AL	4
14. Jacksonville, FL	4
15. Miami, FL	4
16. Jackson, MS	4
17. Charlotte, NC	4
18. Wilmington, NC	4
19. Barnwell, SC	4
20. Columbia, SC	4
21. Knoxville, TN	4
22. Nashville, TN	4
23. Oak Ridge, TN	4
24. Chicago, IL	5
25. Indianapolis, IN	5
26. Lansing, MI	5
27. Minneapolis, MN	5
28. Welch, MN	5
29. Columbus, OH	5
30. Painesville, OH	5
31. Ross, OH	5
32. Little Rock, AR	6
33. Santa Fe, NM	6
34. Austin, TX	6
35. El Paso, TX	6
36. Iowa City, IA	7
37. Topeka, KS	7
38. Denver, CO	8
39. Bismarck, ND	8
40. Pierre, SD	8
41. Salt Lake City, UT	8
42. Phoenix, AZ	9
43. Berkeley, CA	9
44. Los Angeles, CA	9
45. Honolulu, HI	9
46. Las Vegas, NV	9
47. Fairbanks, AK	10
48. Boise, ID	10
49. Idaho Falls, ID	10
50. Portland, OR	10
51. Olympia, WA	10
52. Spokane, WA	10

ERAMS - PRECIPITATION SAMPLING PROGRAM

LOCATION	REGION
1. Hartford, CT	1
2. Augusta, ME	1
3. Concord, NH	1
4. Albany, NY	2
5. Yaphank, NY	2
6. Wilmington, DE	3
7. Harrisburg, PA	3
8. Lynchburg, VA	3
9. Montgomery, AL	4
10. Jacksonville, FL	4
11. Miami, FL	4
12. Charlotte, NC	4
13. Barnwell, SC	4
14. Columbia, SC	4
15. Knoxville, TN	4
16. Nashville, TN	4
17. Chicago, IL	5
18. Lansing, MI	5
19. Minneapolis, MN	5
20. Welch, MN	5
21. Painesville, OH	5
22. Little Rock, AR	6
23. Santa Fe, NM	6
24. Austin, TX	6
25. Iowa City, IA	7
26. Topeka, KS	7
27. Denver, CO	8
28. Bismarck, ND	8
29. Salt Lake City, UT	8
30. Phoenix, AZ	9
31. Berkeley, CA	9
32. Honolulu, HI	9
33. Las Vegas, NV	9
34. Boise, ID	10
35. Idaho Falls, ID	10
36. Portland, OR	10
37. Olympia, WA	10

ERAMS - DRINKING WATER SAMPLING PROGRAM

LOCATION	REGION
1. Hartford, CT	1
2. Lawrence, MA	1
3. Augusta, ME	1
4. Manchester, NH	1
5. Providence, RI	1
6. Trenton, NJ	2
7. Waretown, NJ	2
8. Albany, NY	2
9. New York City, NY	2
10. Niagara Falls, NY	2
11. Syracuse, NY	2
12. Dover, DE	3
13. Baltimore, MD	3
14. Conowingo, MD	3
15. Columbia, PA	3
16. Harrisburg, PA	3
17. Philadelphia, PA (BAXTER)	3
18. Philadelphia, PA (QUEEN)	3
19. Pittsburgh, PA	3
20. Ashland, VA	3
21. Lynchburg, VA	3
22. Dothan, AL	4
23. Montgomery, AL	4
24. Muscle Shoals, AL	4
25. Scottsboro, AL	4
26. Miami, FL	4
27. Tampa, FL	4
28. Baxley, GA	4
29. Savannah, GA	4
30. Jackson, MS	4
31. Port Gibson, MS	4
32. Charlotte, NC	4
33. Wilmington, NC	4
34. Barnwell, SC	4
35. Columbia, SC	4
36. Jenkinsville, SC	4
37. Seneca, SC	4
38. Chattanooga, TN	4
39. Knoxville, TN	4
40. Oak Ridge, TN	4
41. Morris, IL	5
42. West Chicago, IL	5
43. Detroit, MI	5
44. Grand Rapids, MI	5
45. Minneapolis, MN	5
46. Red Wing, MN	5
47. Cincinnati, OH	5
48. Columbus, OH	5
49. East Liverpool, OH	5
50. Painesville, OH	5
51. Toledo, OH	5
52. Genoa, WI	5
53. Madison, WI	5
54. Little Rock, AR	6

ERAMS - DRINKING WATER SAMPLING PROGRAM (CONT'D)

LOCATION	REGION
55. New Orleans, LA	6
56. Santa Fe, NM	6
57. Oklahoma City, OK	6
58. Austin, TX	6
59. Cedar Rapids, IA	7
60. Topeka, KS	7
61. Lincoln, NE	7
62. Jefferson City, MO	7
63. Denver, CO	8
64. Platteville, CO	8
65. Helena, MT	8
66. Bismarck, ND	8
67. Berkeley, CA	9
68. Los Angeles, CA	9
69. Honolulu, HI	9
70. Las Vegas, NV	9
71. Fairbanks, AK	10
72. Boise, ID	10
73. Idaho Falls, ID	10
74. Portland, OR	10
75. Richland, WA	10
76. Seattle, WA	10

ERAMS - PASTEURIZED MILK SAMPLING PROGRAM

LOCATION	REGION
1. Hartford, CT	1
2. Boston, MA	1
3. Portland, ME	1
4. Montpelier, VT	1
5. Trenton, NJ	2
6. Buffalo, NY	2
7. Syracuse, NY	2
8. Dover, DE	3
9. Baltimore, MD	3
10. Philadelphia, PA	3
11. Pittsburgh, PA	3
12. Norfolk, VA	3
13. Charleston, WV	3
14. Montgomery, AL	4
15. Tampa, FL	4
16. Atlanta, GA	4
17. Louisville, KY	4
18. Jackson, MS	4
19. Charlotte, NC	4
20. Chattanooga, TN	4
21. Knoxville, TN	4
22. Memphis, TN	4
23. Chicago, IL	5
24. Indianapolis, IN	5
25. Detroit, MI	5
26. Grand Rapids, MI	5
27. Cincinnati, OH	5
28. Cleveland, OH	5
29. Little Rock, AR	6
30. Albuquerque, NM	6
31. San Antonio, TX	6
32. Ft. Worth, TX	6
33. Des Moines, IA	7
34. Wichita, KS	7
35. Jefferson City, MO	7
36. Rapid City, SD	8
37. Phoenix, AZ	9
38. Los Angeles, CA	9
39. Sacramento, CA	9
40. San Francisco, CA	9
41. Honolulu, HI	9
42. Las Vegas, NV	9
43. Portland, OR	10
44. Tacoma, WA	10
45. Spokane, WA	10

APPENDIX 15.2

ERAMS EQUIPMENT AND SUPPLY REQUEST

ERAMS Equipment and Supply Request/Record
United States Environmental Protection Agency
National Air and Radiation Environmental Laboratory
540 South Morris Avenue
Montgomery, AL 36115-2601
Telephone: (334) 270-3400
Facsimile: (334) 270-3454

1. Date: _____
2. Station Number: _____
3. Station Operator: _____
4. Mailing Address: _____
   _____
   _____
5. Telephone: _____
6. Facsimile: _____
7. Equipment/Supplies Requested:

Air Supplies	Precipitation Supplies
_____ Mailing Envelopes	_____ Cubitainers
_____ Glassine Envelopes	_____ Shipping cartons
_____ Report Forms	_____ Volume labels
_____ Air Filter	_____ Report Forms

Parts: _____
_____

❑ **Please check if reporting change of address or collector.**

Date request processed: ___/___/___ Processed by: _____

Please return this form to the attention of:

ERAMS/Sample Preparation
United States Environmental Protection Agency
National Air and Radiation Environmental Laboratory
540 South Morris Avenue
Montgomery, AL 36115-2601

APPENDIX 15.3

ERAMS AIR AND PRECIPITATION REPORT

APPENDIX 15.4

ERAMS DRINKING WATER REPORT

ERAMS Drinking Water Report
United States Environmental Protection Agency
National Air and Radiation Environmental Laboratory
540 South Morris Avenue
Montgomery, AL 36115-2601
Telephone: (334) 270-3400
Facsimile: (334) 270-3454

1. Date of Collection: _____
2. Quarter: Jan-Mar Apr-Jun Jul-Sep Oct-Dec Year: _____
3. Station: _____
4. Tap Location: _____
5. Name of Collector: _____
6. Address of Collector: _____
7. Shipping Address: _____
8. Telephone: _____
9. Facsimile: _____
10. Comments: _____

❑ **Please check here if reporting change of address or collector.**

The following is provided in accordance with the Paperwork Reduction Act. Public reporting burden for this collection of information is estimated to vary from .58 to 1.35 hours per response, depending on media type collected with an average of 1.08 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect, including suggestions for reducing this burden to the laboratory director at the above address and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503.

APPENDIX 15.5
ERAMS PASTEURIZED MILK REPORT

ERAMS Pasteurized Milk Report

United States Environmental Protection Agency
National Air and Radiation Environmental Laboratory
540 South Morris Avenue
Montgomery, AL 36115-2601
Telephone: (334) 270-3400
Facsimile: (334) 270-3454

1. Date of Collection: _____
2. Quarter: Jan-Mar Apr-June Jul-Sept Oct-Dec Year: _____
3. Principal City: _____
4. Name of Collector: _____
5. Address of Collector: _____
6. Shipping Address: _____
7. Telephone Number of Collector: _____
8. Facsimile Number of Collector: _____
9. EPA Bottle Number: _____
10. Names of Contributing Plants/Dairies: _____
11. Specify pounds or gallons produced per day on the sample collection date by the contributing plants/dairies: _____
12. Comments: _____

❑ Please check here if reporting change of address or collector.

The following is provided in accordance with the Paperwork Reduction Act. Public reporting burden for this collection of information is estimated to vary from .58 to 1.35 hours per response, depending on media type collected with an average of 1.08 hours per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect, including suggestions for reducing this burden to the laboratory director at the address above and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503.

APPENDIX 15.6
ERAMS REPORTING INCREMENTS AND MINIMUM DETECTABLE CONCENTRATIONS

Minimum Detectable Concentrations

Radionuclide	Matrix	Typical Aliquot Size	Count Time	Method	MDC
Gamma Emitters (examples below)	Water	1 L	1000	GS	Varies
	Solids	600 g	1000	GS	Varies
Cesium-134	Water	1 L	1000	GS	4.5 pCi/L
	Solids	600 g	1000	GS	0.011 pCi/g
Cesium-137	Water	1 L	1000	GS	4.4 PCi/L
	Solids	600 g	1000	GS	0.011 pCi/g
Cobalt-60	Water	1 L	1000	GS	4.1 pCi/L
	Solids	600 g	1000	GS	0.011 pCi/g
Iodine-131	Water	1 L	1000	GS	6.0 pCi/L
	Solids	600 g	1000	GS	0.015 pCi/g
Radium-228	Water	1 L	1000	GS	15 pCi/L
	Solids	600 g	1000	GS	0.037 pCi/g
Gross Alpha	Water	200 mL	100	GFP	3 pCi/L
Gross Beta	Water	200 mL	100	GFP	2 pCi/L
	Air Filter	2500 m^3	5	GFP	0.0015 pCi/m^3
Radium-226	Water	1 L	1000	ASC	0.02 pCi/L
	Solids	0.5 g	1000	ASC	0.04 pCi/g
Radium-228	Water	1 L	100	GFP	1 pCi/L
	Solids	0.5 g	100	GFP	2 pCi/g
Iodine-131	Water	2 L	1000	GFP	0.7 pCi/L

Minimum Detectable Concentrations
(Continued)

Radionuclide	Matrix	Typical Aliquot Size	Count Time	Method	MDC
Strontium-89	Water	2 L	100	GFP	1 pCi/L
	Milk	1 L	100	GFP	2 pCi/L
	Solids	0.5 g	100	GFP	4 pCi/g
Strontium-90	Water	2 L	100	GFP	1 pCi/L
	Milk	1 L	100	GFP	2 pCi/L
	Solids	0.5 g	100	GFP	4 pCi/g
Uranium-234, 235, 238 Thorium-230, 232 Plutonium-238, 239 Americium-241	Water	1L	1000	AS	0.1 pCi/L
	Solids	0.5 g	1000	AS	0.2 pCi/g
Thorium-227	Water	1L	1000	AS	0.2 pCi/L
	Solids	0.5 g	1000	AS	0.35 pCi/g
Thorium-228	Water	1L	1000	AS	0.15 pCi/L
	Solids	0.5 g	1000	AS	0.3 pCi/g
Tritium	Water	10 mL	100	LS	0.1 nCi/L

AS Alpha Spectrometry
GFP Gas-flow Proportional Counting
GS Gamma Spectrometry
LS Liquid Scintillation Counting
ASC Alpha Scintillation Cell Counting

APPENDIX 15.7
ERAMS EVENT REPORT

ERAMS Event Report

Network (Circle one): Air Precipitation Drinking Water Milk

Sample ID: _____ Collection date: _____
Location: _____
Analysis: _____

Date	Nuclide	Activity	2 sigma	Unit

Description: _____

Submitted by: _____ Date: _____

Copies to:
ERAMS Manager
Radioanalytical Project Coordinator
Counting Room Manager
NAREL QA Coordinator
MASB Chief
Sample Preparation Lab Manager
MASB Quality Assurance Officer
NAREL QA Chemist

The ERAMS Manager should document actions taken on the other side.

(ERAMS Event Report continued on next page)

Actions Taken

Signature: _____ Date: _____

ERAMS Manager

Signature: _____ Date: _____

MASB Chief